

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Borden, et al.  
Assignee: Boxer Cross, Inc.  
Title: IDENTIFYING DEFECTS IN A CONDUCTIVE STRUCTURE OF A  
WAFER, BASED ON HEAT TRANSFER THERETHROUGH  
Serial No.: Unknown Filing Date: Herewith  
Examiner: Unknown Group Art Unit: Unknown  
Docket No.: M-12169 US

San Jose, California  
March 1, 2002

BOX Patent Application  
COMMISSIONER FOR PATENTS  
Washington, D. C. 20231

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the above-identified patent application as follows (a version with markings to show changes made appears at the end):

IN THE CLAIMS

1. (Unchanged) A method of identifying a defect in a semiconductor wafer, the method comprising:
  - applying heat to a conductive structure formed on said semiconductor wafer;
  - measuring a signal indicative of temperature of a portion of the conductive structure heated by conduction of the applied heat therethrough, thereby to obtain a measurement;
  - repeating the act of measuring at each of a number of different locations on the conductive structure, thereby to obtain a plurality of measurements; and
  - determining presence of the defect in the conductive structure, depending on the plurality of measurements.

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2. (Unchanged) The method of Claim 1, wherein:  
a laser beam is used during said applying of heat;  
reflection of another laser beam is measured during said measuring; and  
the laser beams are scanned together during said measuring.
  3. (Unchanged) The method of Claim 2, wherein:  
the laser beams are coincident, thereby to form a single spot on the conductive structure.
  4. (Unchanged) The method of Claim 1, wherein:  
the conductive structure has at least one dimension less than 1  $\mu\text{m}$ .
  5. (Unchanged) The method of Claim 1, wherein:  
an electron beam is used during said applying of heat.
  6. (Unchanged) The method of Claim 1, wherein:  
a thermal imager is used during said measuring.
  7. (Unchanged) The method of Claim 1, wherein:  
said conductive structure is periodic in space along a direction, and said locations are along said direction.
  8. (Unchanged) The method of Claim 7, wherein:  
said determining includes using a transform of said plurality of measurements, said transform converting said plurality of measurements from a spatial domain into a frequency domain.
  9. (Unchanged) The method of Claim 7, wherein:

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said determining includes identifying a frequency component not found in a corresponding plurality of measurements from a reference wafer.

10. (Unchanged) The method of Claim 7, wherein:

said determining includes comparing a curve defined by said plurality of measurements to a reference curve defined by a corresponding plurality of measurements from a reference wafer.

11. (Unchanged) The method of Claim 7, wherein:

said determining includes comparing a curve defined by said plurality of measurements to a baseline.

12. (Unchanged) The method of Claim 7, wherein:

a measurement is performed at least at a plurality of vias located sequentially one after another in said direction.

13. (Unchanged) The method of Claim 7, wherein:

a pump beam is incident on a first trace in the conductive structure during said applying; and

a probe beam is incident on a second trace in said conductive structure during said measuring; and

wherein said first trace is coupled to said second trace through at least one via.

14. (Unchanged) The method of Claim 11 wherein:

each of said first trace and said second trace are in a single metal layer.

15. (Unchanged) The method of Claim 11, wherein:

each of said first trace and said second trace are in different metal layers.

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16. (Unchanged) The method of Claim 1, wherein:

said determining includes comparing the plurality of measurements to a corresponding plurality of measurements obtained from a reference wafer.

17. (Unchanged) The method of Claim 1, wherein:

said repeated acts of measuring are performed while moving a stage carrying the semiconductor wafer containing the conductive structure; and

performing said measuring continuously, thereby to obtain an analog signal; and

using said analog signal during said determining.

18. (Unchanged) A method for determining the quality of a conductive structure, the method comprising:

applying heat to the conductive structure using a modulated heat source;

measuring a phase difference between temperature change of said conductive structure and modulation of said heat source; and

analyzing said phase difference to determine quality of said conductive structure.

19. (Unchanged) The method of Claim 18 wherein reflection of a laser beam is used to measure the phase difference.

20. (Unchanged) The method of claim 18 wherein said quality is related to a defect in said conductive structure.

21. (Unchanged) The method of Claim 20 wherein said defect is any defect in a group consisting of voiding, narrow trace, and misalignment of a via to a trace.

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22. (Unchanged) A method for determining the quality of a conductive structure, the method comprising:

applying heat to the conductive structure using a modulated heat source;

varying the frequency of modulation of said heat source;

measuring a change in temperature of said conductive structure, as a function of the frequency of modulation; and

analyzing said function to determine the quality of said conductive structure.

23. (Unchanged) The method of Claim 22, wherein reflection of a laser beam is used to measure the temperature change.

24. (Unchanged) The method of Claim 22, wherein heat is applied to said conductive structure using a laser beam.

25. (Unchanged) The method of Claim 22 further comprising:

repeating the act of measuring at each of a number of different locations on the conductive structure, thereby to obtain a plurality of measurements; and

using said plurality of measurements during said analyzing.

26. (Unchanged) The method of Claim 22 further comprising:

moving a stage carrying a semiconductor wafer containing the conductive structure at a fixed speed; and

performing said act of measuring continuously, thereby to obtain an analog signal; and

using said analog signal during said analyzing.

27. (Unchanged) The method of Claim 22 wherein said analyzing comprises:

identifying irregular features in the conductive structure.

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28. (Amended) An apparatus for identifying a defect in a conductive structure, the apparatus comprising:
- a laser for applying heat to the conductive structure;
  - a sensor for measuring a signal indicative of temperature of a portion of the conductive structure heated by conduction of the applied heat therethrough; and
  - means for determining presence of the defect in the conductive structure, based on the measured temperature.
29. (Amended) The apparatus of Claim 28, wherein said sensor for measuring comprises a thermal imager.
30. (Amended) The apparatus of Claim 28 wherein said means for determining comprises a personal computer.

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REMARKS

The last three claims are renumbered because the original application has two claims numbered as 27.

In addition, the claim now numbered as 28 is amended to correct a typographical error ("the sensor" is change to --a sensor--).

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Respectfully submitted,

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- a laser beam is used during said applying of heat;
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a thermal imager is used during said measuring.

7. (Unchanged) The method of Claim 1, wherein:

said conductive structure is periodic in space along a direction, and said locations are along said direction.

8. (Unchanged) The method of Claim 7, wherein:

said determining includes using a transform of said plurality of measurements, said transform converting said plurality of measurements from a spatial domain into a frequency domain.

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said determining includes identifying a frequency component not found in a corresponding plurality of measurements from a reference wafer.

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a probe beam is incident on a second trace in said conductive structure during said measuring; and

wherein said first trace is coupled to said second trace through at least one via.

14. (Unchanged) The method of Claim 11 wherein:

each of said first trace and said second trace are in a single metal layer.

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performing said measuring continuously, thereby to obtain an analog signal; and

using said analog signal during said determining.

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analyzing said phase difference to determine quality of said conductive structure.

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20. (Unchanged) The method of claim 18 wherein said quality is related to a defect in said conductive structure.

21. (Unchanged) The method of Claim 20 wherein said defect is any defect in a group consisting of voiding, narrow trace, and misalignment of a via to a trace.

22. (Unchanged) A method for determining the quality of a conductive structure, the method comprising:

applying heat to the conductive structure using a modulated heat source;

varying the frequency of modulation of said heat source; measuring a change in temperature of said conductive structure, as a function of the frequency of modulation; and

analyzing said function to determine the quality of said conductive structure.

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24. (Unchanged) The method of Claim 22, wherein heat is applied to said conductive structure using a laser beam.

25. (Unchanged) The method of Claim 22 further comprising:

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using said plurality of measurements during said analyzing.

26. (Unchanged) The method of Claim 22 further comprising:  
moving a stage carrying a semiconductor wafer containing the conductive structure at a fixed speed; and  
performing said act of measuring continuously, thereby to obtain an analog signal; and  
using said analog signal during said analyzing.

27. (Unchanged) The method of Claim 22 wherein said analyzing comprises:  
identifying irregular features in the conductive structure.

27 28. (Amended) An apparatus for identifying a defect in a conductive structure, the apparatus comprising:  
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28 29. (Amended) The apparatus of Claim 27 28, wherein said sensor for measuring comprises a thermal imager.

29 30. (Amended) The apparatus of Claim 27 28 wherein said means for determining comprises a personal computer.

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